2.993: Principles of Internet Computing
Quiz #2

2:10 - 3:30 pm April 15, 1999

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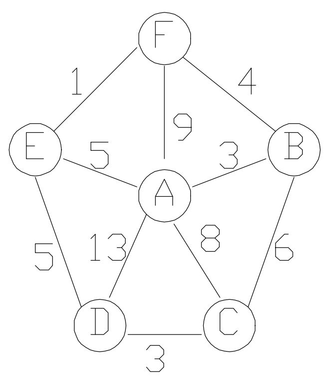
1. *Link-State Routing* (35 pts.)

a) During your job interview as a network engineer, your potential employer asks you questions related to routing in computer networks. In your own words, describe to him/her the "shortest-distance path first" routing concisely. Also, explain to him why this type of routing is called "shortest-distance path first".

[The employer is not interested in an algorithm or a computer code used by a node to update its routing table.]

Ans: In shortest-distance path routing, each node relays distance (cost) information in reaching its immediate neighbors to the entire network. Network flooding of this information is achieved by successively relaying of intermediate nodes to their respective neighbors. Once each router obtains this information, it computes the routing table based on the shortest-path tree using Dijkstra's algorithm.

"Shortest-distance path first" is derived from Dijkstra's algorithm where the path with the shortest distance is *first* moved from the tentative column to the confirmed table.



For the above network topology,

b) Describe the steps necessary to build a routing table (similar to Table 4.6, pp. 173 in the text without the Comments) for node A by applying Dijkstra's algorithm.

Confirmed	Tentative
(A,0,-)	
(A,0,-)	(B,3,B), (C,8,C), (D,13,D), (E,5,E), (F,9,F)
(A,0,-) (B,3,B)	(F,7,B), (D,13, D),(E,5,E), (C,8,C)
(A,0,-) (B,3,B) (E,5,E)	(F,6,E), (D,10,E), (C,8,C)

(A,0,-) (B,3,B) (E,5,E) (F,6,E)	(C,8,C), (D,10,E)
(A,0,-) (B,3,B) (E,5,E) (F,6,E) (C,8,C)	(D,10,E)
(A,0,-) (B,3,B) (E,5,E) (F,6,E) (C,8,C) (D,10,E)	

c) Construct routing tables for nodes A, B and C which contain the shortest-distance path information, using the following format:

(**Destination, Cost, Next Hop**) for each node

[Note: Part (c) can be answered directly from the network graph. Your results from the last step of part (b) should agree with those obtained in part (c) for node A.]

Node	Destination	Cost	Next Hop
A	B	3	B
	C	8	C
	D	10	E
	E	5	E
	F	6	E
B	A	3	A
	C	6	C
	D	9	C
	E	5	F
	F	4	F
C	A	8	A
	B	6	B
	D	3	D
	E	8	D
	F	9	D

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2. *Distance-Vector Routing* (25 pts.)

a) During your job interview as a network engineer, your potential employer asks you questions related to routing in computer networks. In your own words, describe to him/her the "distance-vector" routing concisely. Also, explain to him/her why this type of routing is called "distance-vector".

[The employer is not interested in an algorithm or a computer code used by a node to update its routing table.]

Ans: In distance-vector routing, each router relays the distance (cost) information in reaching all nodes in the network to its neighbors. There is no flooding. Each node sends a *vector* ***D*** to its neighbors, where the *k*th element of this vector, ***D***(*k*), corresponds to the *distance* (cost) in reaching node *k*.

Assume that, for the same network topology of Prob. 1, the nodes use distance-vector and split-horizon algorithms to forward routing information to their neighboring nodes.

b) What does B report to its neighbors?
B reports to A, ***D***=[-, 0, 6, 9, 5, 4]
B reports to C, ***D***=[3, 0, -, -, 5, 4]
B reports to F, ***D***=[3, 0, 6, 9, -, -]

c) What does C report to its neighbors?
C reports to A, ***D***=[-, 6, 0, 3, 8, 9]
C reports to B, ***D***=[8, -, 0, 3, 8, 9]
C reports to D, ***D***=[8, 6, 0, -, -, -]

d) If link CD fails, what does C report to its neighbors?
C reports to A, ***D***=[-, 6, 0, ∞, ∞, ∞]
C reports to B, ***D***=[8, -, 0, ∞, ∞, ∞]
C reports to D, nothing.

e) If link AB fails, what does B report to its neighbors?
B reports to A, nothing.
B reports to C, ***D***=[∞, 0, -, -, 5, 4]
B reports to F, ***D***=[∞, 0, 6, 9, -, -]

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3. *Input-Output Port Matching* (40 pts.)

Output

Input

	1	**2**	**3**
1		2	1
2	2	2	
3	1		3

The above traffic matrix indicates the number of packets buffered at the input ports of a 3-by-3 input-queued switch.

a) Use parallel iterative matching algorithm to determine how the packets at the inputs are transferred to their corresponding outputs. Indicate which packets are chosen in each round of an iteration (time-slot) of the algorithm. How many time-slots does the algorithm take? (Hint: there is no unique answer.)

	X	
X		

+

		X

→

	1	1
1	2	
1		2

	X	
X		

+

		X

→

	0	1
0	2	
1		1

		X
	X	
X		

→

		0
	1	
0		1

Done in 4 steps!

	X	
		X

b) What is the minimum number of time-slots if you use an optimal algorithm to transfer packets from the inputs to the outputs? Prove that your answer is the minimum.
The minimum number of time-slots is 4. Since the maximum sum of packets in each row (or column) is 4, it is the minimum.

c) Suppose now you have a 4-by-4 switch with the following traffic matrix. What is the minimum number of time-slots if you use an optimal algorithm to transfer packets from the inputs to their corresponding outputs?

Input \ Output	**1**	**2**	**3**	**4**
1		2		1
2	2	2		
3			M	
4	1			3

Minimum number of time-slots = max {M, 4}